

**Physics 3500**  
**Weekly Quiz 2**

The position dependent force on an object of mass  $m$  is given as,

$$F(x) = -kx$$

where  $k$  is a positive constant.

- a) Use the force law to derive an equation for the conservation of energy. Be sure to show all steps leading to your final answer.

$$F(x) = m\ddot{x} \quad : \text{force law}$$
$$\downarrow$$
$$-kx = m v \frac{dv}{dx} \rightarrow - \int_{x_0}^x kx dx = \int_{v_0}^v m v dv$$

$$\frac{1}{2} k x_0^2 - \frac{1}{2} k x^2 = \frac{1}{2} m v^2 - \frac{1}{2} m v_0^2 \Rightarrow$$

$$\boxed{\frac{1}{2} k x_0^2 + \frac{1}{2} m v_0^2 = \frac{1}{2} k x^2 + \frac{1}{2} m v^2} \quad \checkmark$$

- b) Using part (a) Identify the potential energy function  $V(x)$ . Verify that it leads to the force law as given in this question.

$$V(x) = \frac{1}{2} k x^2$$

$$\text{and } F(x) = - \frac{\partial V}{\partial x} = - \frac{d}{dx} \left( \frac{1}{2} k x^2 \right)$$
$$= -kx \quad \checkmark$$